formed by the straight line connecting a boundary point 31*a* with the center of the sphere defined by the spherical surface of the corresponding concave portion 31A and the normal to the surface of the bottom of the corresponding concave portion 31A, and it is 2θ, as shown in **FIG. 7**. Therefore, a predetermined percentage of incident light in the three primary color wavelength bands is diffuse-reflected at angles twice the incident angles, up to 2θ. Since the maximum diffuse reflection angle 2θ determines the viewing angle of the projection screen 30, the range of the diffuse reflection angle can be set to enhance viewing characteristics by appropriately designing the concave portions 31A of the substrate 31. Other effects are the same as in the foregoing embodiment, the description is not repeated. The boundary point 31*a*, incidentally, is between the concave portions 31A and flat surfaces of the substrate 31.

[0057] Modification 2

[0058] Although, in the foregoing embodiment, the plurality of convex portions 11A serving as a light diffusion control portion are formed on the surface of the substrate 11 by, for example, embossing, a light diffusion control portion 42 may be provided on a substrate 41, as shown in **FIG. 8**. The light diffusion control portion 42 is essentially composed of a plurality of beads 43 and a bead-fixing layer 44 filling between the beads to fix the beads 43.

[0059] The beads 43 are formed of glass or a transparent material, such as a polymer, in a spherical shape having a uniform diameter d of, for example, several micrometers to several millimeters. The bead-fixing layer 44 is formed of a resin or the like to fix the beads, filling the spaces between the beads 43. The thickness of the bead-fixing layer 44 is, for example, smaller than the diameter d of the beads. Thus, convex portions 42A similar to the convex portions 11A of the foregoing embodiment can be formed on the surface of the light diffusion control portion 42. An optical thin film 12 having the same shape as that of the convex portions 42A of the light diffusion control portion 42 and a protective film 13 are formed on the light diffusion control portion 42 in that order. Thus, a projection screen 40 is completed.

[0060] In this modification, by varying the thickness t of the bead-fixing layer 44 with respect to the diameter d of the beads 43, as shown in **FIG. 9**, the viewing angle can appropriately be set. Specifically, the maximum angle of the diffuse reflection from the optical thin film 12 depends on the angle θ formed by the straight line connecting a boundary point 42*a* between the beads 43 and the bead-fixing layer 44 with the center of the corresponding bead 43 and the normal to the surface of the top of the bead 43, and it is 2θ.

[0061] By varying the thickness t of the bead-fixing layer 44 with respect to the diameter d of the beads 43, the maximum diffuse reflection angle 2θ can be set at a desired value, and, thus, a desired viewing angle can be achieved. Other effects are the same as in the foregoing embodiment, and the description is not repeated.

[0062] Although, in this modification, the light diffusion control portion 42 is essentially composed of the plurality of beads 43 and the bead-fixing layer 44, the light diffusion control portion 42 may have other components. For example, the light diffusion control portion may be a film including a microlens array (MLA), having a plurality of convex portions.

[0063] Although the present invention has been illustrated herein using preferred embodiment and modifications, it is not limited to the form of the embodiment and modifications and other various modifications may be made. For example, while the convex portions 11A have spherical surfaces in the foregoing embodiment, they may be formed in other shapes. For example, the convex portions 11A have oval surfaces or asymmetrical surfaces. Thus, diffuse reflection angles from the optical thin film 12 can be adjusted in the vertical direction and the horizontal direction, by the function of these convex portions.

[0064] Also, while the convex portions 11A are formed by embossing the substrate 11 in the foregoing embodiment, they may be formed by etching. In addition, while, in the foregoing embodiment, the substrate 11 is formed of a macromolecular material containing a black paint to absorb light other than the light in the three primary color wavelength bands, the substrate may be provided with a light absorption layer formed of a black paint on the back surface thereof to absorb the light.

What is claimed is:

  1. A projection screen on which an image is displayed by receiving projection light, comprising:

    a substrate;

    a light diffusion control portion on the surface of the substrate, having a plurality of convex portions or concave portions; and

    an optical thin film on the light diffusion control portion, the optical thin film having convex portions or concave portions having the same shape as that of the convex or concave portions of the light diffusion control portion, the optical thin film reflecting light in a specific wavelength band and transmitting at least visible light other than the light in the specific wavelength band.

  2. A projection screen according to claim 1, wherein the convex portions or concave portions of the light diffusion control portion are formed by processing the substrate.

  3. A projection screen according to claim 2, wherein the convex portions or concave portions are designed by an optical simulation so as to determine the angle of light reflection from the optical thin film.

  4. A projection screen according to claim 3, wherein the convex portions or concave portions of the light diffusion control portion have spherical surfaces.

  5. A projection screen according to claim 1, wherein the light diffusion control portion comprises: a plurality of spherical beads having a predetermined diameter; and a bead-fixing layer filling the spaces between the beads to fix the beads.

  6. A projection screen according to claim 5, wherein the thickness of the bead-fixing layer is set with respect to the diameter of the beads, thereby determining the angle of reflection from the optical thin film.

  7. A projection screen according to claim 1, wherein the optical thin film comprises a dielectric laminate including alternately laminated high-refractive-index layers and low-refractive-index layers, and the thickness of each layer of the dielectric laminate is in the range of 80 to 200 nm.

  8. A projection screen according to claim 7, wherein the high-reflective-index layers comprise a material selected from the group consisting of Nb_2O_5, TiO_2, and Ta_2O_5.